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**(54) DIGITAL SIGNAL PROCESSING METHODDIGITAL SIGNAL
PROCESSING UNITDIGITAL SIGNAL RECORDING METHODDIGITAL
SIGNAL RECORDERRECORDING MEDIUMDIGITAL SIGNAL
TRANSMISSION METHOD AND DIGITAL SIGNAL TRANSMITTER**

(57)Abstract:

PROBLEM TO BE SOLVED: To improve the static characteristic and the sound quality by conducting an adjustment operation depending on an input digital signal and realizing more efficient coding with a proper processing amount resulting from the adjustment operation.

SOLUTION: In the case of calculating a bit share amount for each 2-dimension block with respect to time and frequency and a total number of assigned bits for all the 2-dimension blocks is not matching a bit rate specified by a coding format depending on a result of integer processing of the bit share amount or the likean arithmetic means in a bit assignment calculation circuit 118 calculates a maximum possible quantization error in the 2-dimension blocks based on the bit assigned amount calculated tentatively and normalized data or a maximum signal component in the 2-dimension blocks for each 2-dimension block with respect to time and frequency in order to make them match each otherand conducts the adjustment operation of bits based on the bit necessity by recognizing the maximum quantization error as the bit necessity of each 2-dimension block.

CLAIMS

[Claim(s)]

[Claim 1]Divide an input digital signal into two or more frequency band componentsand a signal component within time and two or more two-dimensional blocks related with frequency is obtainedNormalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and

frequency and normalization data is obtained. A quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculated. Determine bit allocation quantities based on this quantization coefficient for every two-dimensional block about the above-mentioned time and frequency. Quantize a signal component within a block with the above-mentioned normalization data and bit allocation quantities and carry out an information compression. In a digital signal processing method which obtained an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block. When bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this. For every two-dimensional block about the above-mentioned time and frequency the amount of bit assignment computed provisionally. Normalization data or based on the greatest signal component within a two-dimensional block. A digital signal processing method computing the greatest quantization error that may happen within a two-dimensional block considering that a quantization error of this maximum is a bit necessity degree of two dimension blocks each and performing adjustment operation of a bit based on this bit necessity degree.

[Claim 2] Divide an input digital signal into two or more frequency band components and a signal component within time and two or more two-dimensional blocks related with frequency is obtained. Normalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency and normalization data is obtained. A quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculated. Determine bit allocation quantities based on this quantization coefficient for every two-dimensional block about the above-mentioned time and frequency. Quantize a signal component within a block with the above-mentioned normalization data and bit allocation quantities and carry out an information compression. An information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block is obtained. In time by which the information compression was carried out [above-mentioned] and a digital signal processing method which decoded a signal component within two or more two-dimensional blocks related with frequency using an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block. When bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency and a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format by a relation which performs integer-ization of bit allocation quantities etc. in order to coincide this. The amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about the above-mentioned time and frequency. Or a digital signal processing method computing the greatest quantization error that may happen within a two-dimensional block based on the greatest signal component within a two-dimensional block considering that a quantization error of this maximum is a bit necessity degree of two dimension blocks each and performing adjustment operation of a bit based on this bit necessity degree.

[Claim 3] A zone division means to divide an input digital signal into two or more frequency band components.

An orthogonal transformation means which carries out orthogonal transformation of the signal and obtains a signal component for coding within time and two or more two-dimensional blocks related with frequency or analysis.

A normalization data calculating means which normalizes based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency and obtains normalization data.

A quantization coefficient calculating means which calculates a quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency.

A bit distribution calculating means which determines bit allocation quantities based on this quantization coefficient. A compression coding means which quantizes a signal component within a block with the above-mentioned normalization data and bit allocation quantities and carries out an information compression for every two-dimensional block about the above-mentioned time and frequency and an information-compression parameter determination means which obtains an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block.

When it is the digital signal processing device provided with the above and bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this, the amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about the above-mentioned time and frequency or based on the greatest signal component within a two-dimensional block, the greatest quantization error that may happen within a two-dimensional block was computed, it is considered that a quantization error of this maximum was a bit necessity degree of two dimension blocks each and a means to perform adjustment operation of a bit based on this bit necessity degree was formed.

[Claim 4] A zone division means to divide an input digital signal into two or more frequency band components.

An orthogonal transformation means which carries out orthogonal transformation of the signal and obtains a signal component for coding within time and two or more two-dimensional blocks related with frequency or analysis.

A normalization data calculating means which normalizes based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency and obtains normalization data.

A quantization coefficient calculating means which calculates a quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency.

A bit distribution calculating means which determines bit allocation quantities based on this quantization coefficient. A compression coding means which quantizes a signal component within a block with the above-mentioned normalization data and bit

allocation quantities and carries out an information compression for every two-dimensional block about the above-mentioned time and frequency. An information-compression parameter determination means which obtains an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block. Time by which the information compression was carried out [above-mentioned] and a decoding means which decodes a signal component within two or more two-dimensional blocks related with frequency using an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block.

When it is the digital signal processing device provided with the above and bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this. The amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about the above-mentioned time and frequency. Or based on the greatest signal component within a two-dimensional block, the greatest quantization error that may happen within a two-dimensional block was computed. It is considered that a quantization error of this maximum was a bit necessity degree of two dimension blocks each and a means to perform adjustment operation of a bit based on this bit necessity degree was formed.

[Claim 5] Divide an input digital signal into two or more frequency band components and a signal component within time and two or more two-dimensional blocks related with frequency is obtained. Normalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency and normalization data is obtained. A quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculated. Determine bit allocation quantities based on this quantization coefficient and for every two-dimensional block about the above-mentioned time and frequency, quantize a signal component within a block with the above-mentioned normalization data and bit allocation quantities and an information compression is carried out. In a digital signal record method recorded on a recording medium with an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block. When bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this. For every two-dimensional block about the above-mentioned time and frequency, the amount of bit assignment computed provisionally, normalization data or based on the greatest signal component within a two-dimensional block. A digital signal record method computing the greatest quantization error that may happen within a two-dimensional block, considering that a quantization error of this maximum is a bit necessity degree of two dimension blocks each and performing adjustment operation of a bit based on this bit necessity degree.

[Claim 6] A digital signal recorder comprising:

A zone division means to divide an input digital signal into two or more frequency band components.

An orthogonal transformation means which carries out orthogonal transformation of the signal and obtains a signal component within time and two or more two-dimensional blocks related with frequency.

A normalization data calculating means which normalizes for every two-dimensional block about the above-mentioned time and frequency based on a signal component for coding within a two-dimensional block and obtains normalization data.

A quantization coefficient calculating means which calculates a quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency.

A bit distribution calculating means which determines bit allocation quantities based on this quantization coefficient.

A compression coding means which quantizes a signal component within a block with the above-mentioned normalization data and bit allocation quantities and carries out an information compression for every two-dimensional block about the above-mentioned time and frequency.

It has an information-compression parameter determination means which obtains an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block.

In a digital signal recorder which recorded both outputs of the above-mentioned compression coding means and the above-mentioned information-compression parameter determination means on a recording medium.

When bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this.

The greatest quantization error that may happen within a two-dimensional block is computed for every two-dimensional block about the above-mentioned time and frequency based on the greatest signal component within the amount of bit assignment computed provisionally.

Normalization data for a two-dimensional block means to consider that a quantization error of this maximum is a bit necessity degree of two dimension blocks each and to perform adjustment operation of a bit based on this bit necessity degree.

[Claim 7] Divide an input digital signal into two or more frequency band components and a signal component within time and two or more two-dimensional blocks related with frequency is obtained.

Normalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency and normalization data is obtained.

A quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculated.

Determine bit allocation quantities based on this quantization coefficient and for every two-dimensional block about the above-mentioned time and frequency.

quantize a signal component within a block with the above-mentioned normalization data and bit allocation quantities and an information compression is carried out.

on a recording medium recorded with an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block.

When bit allocation quantities are

computed for every two-dimensional block about the above-mentioned time and frequency by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this, the greatest quantization error that may happen within a two-dimensional block is computed for every two-dimensional block about the above-mentioned time and frequency based on the greatest signal component within the amount of bit assignment computed provisionally. Normalization data for a two-dimensional block. A recording medium considering that a quantization error of this maximum is a bit necessity degree of two dimension blocks each and performing adjustment operation of a bit based on this bit necessity degree.

[Claim 8] Divide an input digital signal into two or more frequency band components and a signal component within time and two or more two-dimensional blocks related with frequency is obtained. Normalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency and normalization data is obtained. A quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculated. Determine bit allocation quantities based on this quantization coefficient and for every two-dimensional block about the above-mentioned time and frequency, quantize a signal component within a block with the above-mentioned normalization data and bit allocation quantities and an information compression is carried out. In a digital signal transmission method which transmits with an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block. When bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this, for every two-dimensional block about the above-mentioned time and frequency the amount of bit assignment computed provisionally. Normalization data based on the greatest signal component within a two-dimensional block. A digital signal transmission method computing the greatest quantization error that may happen within a two-dimensional block considering that a quantization error of this maximum is a bit necessity degree of two dimension blocks each and performing adjustment operation of a bit based on this bit necessity degree.

[Claim 9] When bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency in a digital signal sending set characterized by comprising the following by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this, the amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about the above-mentioned time and frequency. Or based on the greatest signal component within a two-dimensional block, the greatest quantization error that may happen within a two-dimensional block is computed. A digital signal sending set forming a means to consider that a quantization error of this maximum is a bit necessity degree of two dimension blocks each and to

perform adjustment operation of a bit based on this bit necessity degree.

A zone division means to divide an input digital signal into two or more frequency band components.

An orthogonal transformation means which carries out orthogonal transformation of the signal and obtains a signal component for coding within time and two or more two-dimensional blocks related with frequency analysis.

A normalization data calculating means which normalizes based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency and obtains normalization data.

A quantization coefficient calculating means which calculates a quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency. A bit distribution calculating means which determines bit allocation quantities based on this quantization coefficient. A compression coding means which quantizes a signal component within a block with the above-mentioned normalization data and bit allocation quantities and carries out an information compression for every two-dimensional block about the above-mentioned time and frequency. A transmitting means which transmits both outputs of an information-compression parameter determination means which obtains an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block and the above-mentioned compression coding means and the above-mentioned information-compression parameter determination means.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a digital signal processing method, a digital signal processing device, a digital signal recording method, a digital signal recorder, a recording medium, a digital signal transmission method, and a digital signal sending set.

[0002]

[Description of the Prior Art] Although it is in the conventional method and device of high efficiency coding of an audio signal, variously the example of 2 and 3 of a conventional example is explained below. The audio signal of a segment of time is blocked for every unit time and the signal of the time-axis for this the block of every is changed into the signal on a frequency axis (orthogonal transformation); it divides into two or more frequency bands and there is the conversion coding method which is one of the blocking frequency-band-division methods coded for every zone. There is the zone part tally item-ized {subband coding (SBC: Subband Coding)} method which is one of the deblocking frequency-band-division methods divided and coded to two or more frequency bands without blocking the audio signal of a segment of time for every unit time. There is also a highly efficient encoding method which combined the above-mentioned formation of a zone part tally item and conversion coding. In this case, after performing zone division by the above-mentioned zone part tally item-ized

method orthogonal transformation of the signal for every zone of that will be carried out to the signal of a frequency domain by the above-mentioned conversion coding method and it will code for each [by which orthogonal transformation was carried out] of this zone of every for example.

[0003] As a filter for zone division used for the zone part tally item-ized method mentioned above here For example there is a filter of a mulberry DORACHA mirror filter (QMF: Quadrature Mirror Filter) etc. This is 1976 R.E. Crochiere Digital coding of speech in subbands Bell Syst. Tech. J. Vol. 55 and No. 8. It is stated to 1976. To ICASSP 83 and BOSTON Polyphase Quadrature filters-A new subband coding technique Joseph H. Rothweiler, a polyphase mulberry DORACHA filter (PQF: Polyphase Quadrature filter) etc. -- etc. -- the filter split method and device of the bandwidth are described.

[0004] As orthogonal transformation mentioned above an input audio signal is blocked by prescribed unit time (frame) for example There is a method that a time-axis is changed into a frequency axis by performing Fast Fourier Transform (FFT) a discrete cosine transform (DCT) modified DCT transformation (MDCT) etc. for the block of every. To above-mentioned MDCT. Therefore ICASSP 1987 Subband/Transform Coding Using Filter Bank Designs Based on Time Domain Aliasing Cancellation J.P. Princen, A.B. It is stated to Bradley Univ. of Surrey Royal Melbourne Inst. of Tech.

[0005] There is zone division in consideration of human being's aural characteristic as frequency division width in the case of quantizing each frequency component by which frequency band division was carried out. That is an audio signal may be divided into the zone of two or more bands (for example 25 bunt) with the bandwidth that bandwidth becomes large as the high region currently generally called the critical band (critical band). When coding the data for every zone at this time predetermined bit distribution or coding according to accommodative bit distribution the whole zone is performed for every zone. For example when coding the MDCT coefficient data produced by MDCT processing of the **** being carried out by above-mentioned bit distribution coding will be performed with the accommodative distribution number of bits to the MDCT coefficient data for every zone obtained by the MDCT processing for every above-mentioned block.

[0006] What is called block floating (Block Floating: block floating) processing in which more efficient coding is realized is performed by quantizing by normalizing for every zone on the occasion of the coding for every zone. Namely when coding the MDCT coefficient data produced by MDCT processing of the **** being carried out quantizes by performing normalization corresponding to the maximum of the absolute value of an above-mentioned MDCT coefficient etc. for every zone. Thereby more efficient coding is performed.

[0007] As an above-mentioned bit distribution method the two following methods are known conventionally. In IEEE Transactions of Acoustics Speech and Signal Processing vol. ASSP-25 No. 4 and August 1977 bit distribution is performed based on the size of the signal for every zone. ICASSP 1980 The critical. In band coder - digital encoding of the perceptual requirements of the auditory system M.A. Kramersner MIT by using auditory masking. The method of obtaining a required signal to noise ratio for every zone and performing fixed bit distribution is described.

[0008]

[Problem(s) to be Solved by the Invention] By the way when the bit allocation quantities

for every zone which quantizes are computed in the conventional highly efficient encoding method and device which were mentioned above. Since the total of the quota bit of all the zones generally is not in agreement with the bit rate specified by a coding format by the relation which performs integer-ization of bit allocation quantities etc., bit adjustment operation is needed in order to coincide this. Although how to perform by the priority for which it depended on frequency simply as this bit adjustment operation for example can be considered, it will not be dependent on an input signal at all in this case and adapted adjustment operation cannot be performed, however the case where bit adjustment depending on an input signal is performed strictly -- all the signal components -- a quantization error -- it will be necessary to take a masking effect etc. into consideration again and processing will become large dramatically as adjustment operation.

[0009] This invention is made in view of such the actual condition and an input digital signal is divided into two or more frequency band components. Obtain the signal component within time and two or more two-dimensional blocks related with frequency and normalize based on the signal component within a two-dimensional block for every two-dimensional block about time and frequency and normalization data is obtained. The quantization coefficient which expresses the feature of the signal component within a two-dimensional block for every two-dimensional block about time and frequency is calculated. Determine bit allocation quantities based on the quantization coefficient for every two-dimensional block about time and frequency. Quantize the signal component within a block with normalization data and bit allocation quantities and carry out an information compression and. A digital signal processing method which obtained the information-compression parameter for every [about time and frequency] two-dimensional block. A digital signal processing device, a digital signal record method, a digital signal recorder, a recording medium, a digital signal transmission method. Or in a digital signal sending set, adjustment operation depending on an input digital signal is performed. More efficient coding is realized by a throughput suitable as adjustment operation and what can aim at improvement in a static characteristic or a signal quality is proposed.

[0010]

[Means for Solving the Problem] This invention divides an input digital signal into two or more frequency band components. Obtain a signal component within time and two or more two-dimensional blocks related with frequency and normalize based on a signal component within a two-dimensional block for every two-dimensional block about time and frequency and normalization data is obtained. A quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about time and frequency is calculated. Determine bit allocation quantities based on the quantization coefficient for every two-dimensional block about time and frequency. Quantize a signal component within a block with normalization data and bit allocation quantities and carry out an information compression and. In a digital signal processing method which obtained an information-compression parameter for every [about time and frequency] two-dimensional block. When bit allocation quantities are computed for every two-dimensional block about time and frequency by a relation which performs integer-ization of bit allocation quantities etc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a

coding format in order to coincide this. For every two-dimensional block about time and frequency, the amount of bit assignment computed provisionally for normalization data is based on the greatest signal component within a two-dimensional block. The greatest quantization error that may happen within a two-dimensional block is computed. It considers that the greatest quantization error is a bit necessity degree of two dimension blocks each and adjustment operation of a bit is performed based on the bit necessity degree.

[0011] According to the digital signal processing method of this invention, adjustment operation depending on an input digital signal can be performed more efficiently and coding can be realized by a throughput suitable as adjustment operation and improvement in a static characteristic or a signal quality can be aimed at.

[0012]

[Embodiment of the Invention] Hereafter, an embodiment of the invention is described with reference to drawings. In this embodiment, input digital signals such as an audio PCM signal. High efficiency coding is carried out using each art of the formation (SBC) of a zone part tally item, adaptive transform coding {adaptive transformation coding (ATC: Adaptive Transform Coding)} and adaptation BITSUTO assignment. This art is explained referring to drawing 1 or subsequent ones.

[0013] In the concrete high-efficiency-coding encoder shown in drawing 1, divide an input digital signal into two or more frequency bands and perform orthogonal transformation for every frequency band and the spectrum data of the obtained frequency axis in low-pass, what is called every [in consideration of human being's aural characteristic mentioned later] critical band width (critical band) -- junior and senior high schools -- in the region for every zone which subdivided critical band width in consideration of block flow TEIGU efficiency BITSUTO assignment was carried out accommodative and it has coded. Usually, this block turns into a quantization noise generating block. In an embodiment of the invention, block size (block length) is changed accommodative according to an input signal before orthogonal transformation.

[0014] Namely, PCM after the sampling frequency was sampled for the audio signal of a 0-22-kHz frequency band by 44.1 kHz in drawing 1 for example -- the input audio PCM signal acquired by -izing [a PCM signal] is supplied to the input terminal 100. This input audio PCM signal is divided into a 0-11-kHz zone and 11 kHz - a 22-kHz zone by the zone dividing filters 101 such as what is called a QMF (mulberry DORACHA mirror filter) filter for example. Similarly, the signal of a 0-11-kHz zone is divided into a 0 - 5.5 kHz zone and 5.5 kHz - 11-kHz zone by the zone dividing filters 102 such as what is called a QMF filter.

[0015] The signal of 11 kHz - the 22-kHz zone from the above-mentioned zone dividing filter 101. The MDCT (Modified Discrete Cosine Transform) circuit (modified one and discrete cosine transform means) (orthogonal transformation means) 103 which is an example of an orthogonal transformation circuit is supplied and MDCT processing is carried out. The signal of 5.5 kHz - 11-kHz zone from the zone dividing filter 102 is supplied to MDCT circuit (modified one and discrete cosine transform means) (orthogonal transformation means) 104 and MDCT processing is carried out. The zone dividing filters 102-0 - 5.5 kHz zone signal are supplied to MDCT circuit (modified one and discrete cosine transform means) (orthogonal transformation means) 105 and MDCT processing is carried out. In each MDCT circuits 103, 104 and 105, MDCT processing is

made based on the block size (information-compression parameter) (the length of a processing block) determined by the block determining circuits 109110and 111 provided for every zone.

[0016]As mentioned aboveas a means to divide an input digital signal into two or more frequency bandsthere is a QMF filterfor examplebut. About thisit is 1976

R.E.CrochiereDigital Coding of Speech In Subbands Bell Syst.Tech. J. Vol.55 and No.8. It is stated to 1976. The filter split method of the ** bandwidth is stated to ICASSP 83 and Boston Polyphase Quadrature Filters-A New Subband Coding Technique Joseph H. Rothweiler. As orthogonal transformation mentioned abovean input audio signal is blocked by prescribed unit time (frame) herefor exampleThe orthogonal transformation which changed the time-axis into the frequency axis occurs by performing Fast Fourier Transform (FFT)a discrete cosine transform (DCT)modified DCT transformation (MDCT)etc. for the block of every. To MDCT. ThereforeICASSP 1987

Subband/Transform Coding Using Filter Bank Designs Based On Time Domain AliasingCancellation J.P.Princen A. B. It is stated to Bradley Univ.of Surrey Royal MelbourneInst. Of Tech.

[0017]Herethe example over the standard input digital signal about the block for every zone supplied to each MDCT circuits 103104and 105 is shown in drawing 2. Three filter output signals have two or more orthogonal transformation block sizes respectively independently for every zoneand he is trying to have time resolution switched by the time characteristics of a signalfrequency distributionetc. in the example of this drawing 2, a signal -- time -- semi -- in being steadyit enlarges orthogonal transformation block size with 11.6mS like the long mode of drawing 2 A. When a signal is unsteady-likeorthogonal transformation block size is considered as further 2 division and quadrisecton. Namelylike the short mode of drawing 2 B like the case where all are made into the time resolution of quadrisectoni.e.2.9mSthe middle mode A of drawing 2 Cand the middle mode B of drawing 2 DIt is adapted for a actual complicated input digital signal by making a part into two divisioni.e.5.8mSand making other one copy into the time resolution of quadrisectoni.e.2.9mS. The more effective thing is clarif the scale of a processing unit allows division of this orthogonal transformation block size and still more complicated division will be performed.

[0018]A decision of this orthogonal transformation block size is made in the determining circuits (determination means of orthogonal transformation block size) 109110and 111 of orthogonal transformation block sizeThe decision results are supplied to each MDCT circuits 103104and 105 and the bit quota calculation circuit 118and they are outputted from the output terminals 113115and 117 as block size information on a block (information on the length of a processing block) (information-compression parameter).

[0019]The spectrum data on the frequency axis produced by MDCT processing being carried out in each MDCT circuits 103104and 105Or MDCT coefficient data (signal component within the two-dimensional block about time and frequency)low-pass is summarized to what is called every critical band (critical band) -- junior and senior high schools -- in consideration of the validity of block floatinga region subdivides critical band width and is supplied to the adaptation bit allocation code-ized circuits 106107and 108 and the bit assignment calculation circuit 118.

[0020]This seaside zone (critical band) is a frequency band divided in consideration of human being's aural characteristicand is a zone which that noise in case the mask of the

pure sound is carried out by the narrow-band band noise of the same strength near the frequency of a certain pure sound has. In this critical band (critical band)bandwidth is large like the high region and the perimeter wave number zone which is above-mentioned 0-22 kHz is divided into the critical band of 25.

[0021]The bit quota calculation circuit 118 takes into consideration what is called a masking effect etc. based on above-mentioned block size information and spectrum data or MDCT coefficient dataEnergy or a peak value for every masking quantity and isomerism rate zone for every partition-bands region in consideration of an above-mentioned critical band and block floatingetc. is computedit asks for the quota number of bits for every zone based on the resultand the adaptation bit allocation code-ized circuits 106107and 108 are supplied. In these adaptation bit allocation code-ized circuits 106107and 108. Above-mentioned block size information (information-compression parameter) (the length of a processing block)And according to the number of bits assigned for each [in consideration of a critical band and block floating] partition-bands region of everyit is made to carry out re quantization (it normalizes and quantizes) of each spectrum data or the MDCT coefficient data. Thus the coded data is taken out via the output terminals 112114and 116 in drawing 1. Each partition-bands region which took into consideration below the above-mentioned critical band and block floating of explanation which serve as a unit of bit assignment for convenience is made into ** called a unit block.

[0022]Nextthe concrete method of the bit assignment performed in the bit assignment calculation circuit 118 in above-mentioned drawing 1 is explained with reference to drawing 3. Drawing 3 is a block circuit diagram showing the outline composition of one example of the bit assignment calculation circuit 118 in above-mentioned drawing 1. In this drawing 3the block size information from the spectrum data on the frequency axis from MDCT circuits 103104and 105 in above-mentioned drawing 1 or a MDCT coefficientand the block determining circuits 109110and 111 in above-mentioned drawing 1 is supplied to the input terminal 301. Henceforthin the system of the bit assignment calculation circuit 118 in above-mentioned drawing 1 shown by drawing 3it processes using a constanta weighting functionetc. which were adapted for above-mentioned block size information.

[0023]In drawing 3the spectrum data or the MDCT coefficient on the frequency axis inputted from the input terminal 301The energy calculation circuit (every zone energy calculation means) 302 is suppliedand the energy for every unit block is searched for by calculating total of each amplitude value within a unit blockfor example etc. The peak value of amplitude valueaverage valueetc. may be used instead of the energy for every band of this. As an output from this energy calculation circuit 302the spectrum of the total value of each band is shown in drawing 6 as SBfor example. Howeverat this drawing 6in order to simplify a graphic displaythe number of partitions by unit block is expressed by 12 blocks (B1 - B12). The dashed line of drawing 6 shows the influence which spectrum SB of the total value of each band has on other portionsand corresponds to weighting of a convolution.

[0024]In the energy calculation circuit 302it shall determine also about the scale-factor (normalization data) (information-compression parameter) value which shows the state of block floating of a unit block and which is normalization data.While preparing some positive values as a candidate of a scale-factor value concrete for example beforehand

and taking the value more than the spectrum data within a unit block the maximum of the absolute value of a MDCT coefficient from the inside adopts as a scale-factor value of a unit block of the minimum thing. What is necessary is to be a actual value and a form where it corresponded to assign a number and just to make the number memorize by ROM (not shown) etc. about a scale-factor value using several bits. The scale-factor value determined by the above-mentioned method in a certain unit block is used as sub information which shows the scale factor of a unit block of the number were numbered using the above-mentioned bit corresponding to the determined value.

[0025] Next in order to take into consideration the influence what is called in masking of above-mentioned spectrum SB calculated in the above-mentioned energy calculation circuit 302 reeving (convolution) processing which hangs and adds a predetermined weighting function to the spectrum SB is performed. For this reason each value of the output of the energy calculation circuit 302 for every above-mentioned zone i.e. that spectrum SB is supplied to the reeving filter network 303. The reeving filter network 303 comprises two or more delay elements which delay input data one by one two or more multipliers which carry out the multiplication of the filter factor (weighting function) to the output from these delay elements and a total adding machine which takes total of each output multiplier. By this reeving processing total of the portion shown by the drawing 6 middle point line is obtained.

[0026] Next the output of the above-mentioned reeving filter network 303 is supplied to the subtraction machine (composing device) (synthesizing means) 304 (subtraction means). The subtraction machine 304 asks for the level alpha corresponding to the noise level (allowable noise level) (quantization coefficient) in which the permission in the collapsed above-mentioned field mentioned later is possible. The level alpha corresponding to a permissible noise level is a level which turns into an allowable noise level for every band of a critical band by performing reverse convolution processing as mentioned later. Here the admissible function (function expressing a masking level) for asking for the above-mentioned level alpha is supplied to the above-mentioned subtraction machine 304. The above-mentioned level alpha is controlled by making this admissible function fluctuate. The admissible function is supplied from the function generating circuit (n-ai) 305 which is explained below. [0027] That is if the number given sequentially from low-pass [of the band of a critical band] is set to i it can ask for the level alpha corresponding to an allowable noise level by the several 1 following formula.

[0028]

[Equation 1] $\text{Alpha} = S - (n - ai)$

[0029] The bark spectrum (Bark Spectrum) (it is a unit of a critical band and) by which reeving processing of $a > 0$ and the S was carried out by the constant in this several 1 formula as for n and a. What was represented as one spectrum to one critical band. It is intensity and the inside (n-ai) of the formula of several 1 serves as an admissible function. $n = 38$ and $a = 1$ can be used as an example.

[0030] Thus the above-mentioned level alpha is called for and this data is supplied to the divider 306. It is for carrying out the reverse convolution of the above-mentioned level alpha in an above-mentioned field by which the reeving was carried out in the divider 306. Therefore a masking spectrum comes to be acquired from the above-mentioned level alpha by performing this reverse KOMBORI U-SHIN processing. That is this masking spectrum turns into a permission noise spectrum. Although above-mentioned reverse

convolution processing needs a complicated operation it is performing a reverse convolution using the simplified divider 306 in this embodiment.

[0031] Next an above-mentioned masking spectrum is supplied to the subtractor 308 via the synthetic circuit 307. Here it is supplied to the subtractor circuit 308 via the delay circuit 309 above-mentioned output spectrum SB mentioned above from the energy detector circuit 302 for every zone. Therefore as shown in drawing 7 by subtraction operation of an above-mentioned masking spectrum and spectrum SB being performed in this subtractor circuit 308 below a level in which above-mentioned spectrum SB is shown on a level of that masking spectrum MS will be masked.

[0032] By the way in the case of composition in the synthetic circuit 307 mentioned above data in which what is called minimum audible curve RC that is the aural characteristic of human being as shown in drawing 8 supplied from the minimum audible curve generation circuit 312 is shown and above-mentioned masking spectrum MS are compoundable. In this minimum audible curve if a noise absolute level becomes below in this minimum audible curve that noise can be heard. Even if this minimum audible curve has the same coding it becomes that which differs by difference in a reproduction volume at the time of reproduction but in a realistic digital system. For example since there is no difference in how so much if quantization noise of a frequency band near 4 kHz which an ear hears easiest cannot be heard for example in other frequency bands it is thought that quantization noise below a level of this minimum audible curve cannot be heard. [music to 16 BITS/UTO dynamic range] Therefore it is assumed that usage depending on which noise near 4 kHz of word length which a system has in this way cannot be heard is carried out. When an allowable noise level is obtained by compounding both this minimum audible curve RC and masking spectrum MS an allowable noise level in this case. In addition it can carry out now to a portion shown with a slash in drawing 8 in this embodiment the 4-kHz level of the above-mentioned minimum audible curve is set for example by a minimum level of 20 BITS/UTO. This drawing 8 also shows signal spectrum SS simultaneously.

[0033] Then in the permissible noise correction circuit (permissible noise compensation means) 310 allowable noise level in an output from the above-mentioned subtractor 308 is amended based on information on an equal loudness curve. It is connected with a curve in quest of sound pressure of a sound in each frequency which it is here and an equal loudness curve is a characteristic curve about human being's aural characteristic for example the same size as a pure sound of 1 kHz heard and is also called an equal loudness contour of loudness. minimum audible curve RC which showed drawing 8 these loudness level contours -- abbreviated -- the same curve is drawn. In these loudness level contours for example near 4 kHz even if sound pressure falls by 8-10 dB from a place of 1 kHz the same size as 1 kHz heard and unless it is higher than sound pressure in 1 kHz about 15 dB near 50 Hz the same size does not hear conversely. For this reason noise (allowable noise level) beyond a level of the above-mentioned minimum audible curve is understood that it is good to have a frequency characteristic given in a curve according to those loudness level contours. Such a thing shows that amending an above-mentioned allowable noise level in consideration of above-mentioned loudness level contours conforms to human being's aural characteristic. Based on various parameters such as masking mentioned above by a series of processings so far in the permissible noise correction circuit 310 and an aural characteristic it assigns provisionally to each unit

block and a bit is computed.

[0034] A total which totaled a quota bit provisionally computed by the processing so far for every unit block in the permissible noise correction circuit 310. Since it is not in agreement with the usable number of bits generally determined by the bit rate of coding equipment, remedial operation for coinciding this is performed. When there are few totals which totaled a computed above-mentioned quota bit as this correcting method maintained a relative relation during a unit block of a quota bit computed for every unit block than the usable number of bits, what is necessary is just to reduce the whole quota number of bits uniformly as drawing 10 shows when there are more totals which totaled a quota bit which pulls up the whole quota number of bits uniformly as drawing 9 shows and by which **** was computed than the usable number of bits. That is from the permissible noise correction circuit 310 a quota bit of each unit block after performing this remedial operation is outputted. Although an example performed about this remedial operation in the above-mentioned permissible noise correction circuit 310 was shown when performing fraction adjustment later mentioned in a stage of final processing after this compensation process in a series of processings in drawing 3 it is also possible to carry out in a stage before the above-mentioned permissible noise correction circuit 310.

[0035] Since a bit assigned value of each unit block which can be found by a series of processings but so far so that it is possible to make mostly into the same number a total which totaled a quota bit and the usable number of bits by above-mentioned remedial operation is computed as the real value, it will need to perform integer-ization by omission etc. practically. It will be necessary to perform integer-ization as a bit assigned value of a range allowed in a format of coding also with a unit block computed more mostly than the maximum bit assignment number allowed in a format of coding and a unit block computed by above-mentioned remedial operation as a negative value. Generally by operation of this integer-izing the usable number of bits again determined by a total and the bit rate of a quota bit will not be in agreement and remainder of a bit or shortage of a bit will arise. When there are few totals which totaled a computed quota bit at this time than the usable number of bits, a bit will be left and in order to perform more efficient coding operation which assigns a surplus usable bit as much as possible is needed. Since it cannot code correctly when a bit is insufficient of more totals which totaled a computed quota bit conversely than the usable number of bits, operation of decreasing the quota number of bits is needed. Hereafter adjustment operation which is needed by integer-ization within the limits of this coding format etc. is made into a thing of explanation called fraction adjustment for convenience.

[0036] Bit assignment which is normalization data and word length which are the scale factors (normalization data) (information-compression parameter) of each unit block in the fraction equalization circuit 313 in drawing 3. Or from the greatest signal component within a unit block the greatest quantization error that may happen within each unit block is computed and it is made to perform fraction adjustment operation for a size of this greatest quantization error based on this as a bit necessity degree of each unit block.

[0037] Below a calculating method of the greatest quantization error used as an index of a bit necessity degree of each unit block in the fraction equalization circuit 313 is explained.

[0038] First data which processed an orthogonal transformation output spectrum obtained as main information by sub information using drawing 11. An example of coding by word

length which shows a scale factor (normalization data) (information-compression parameter) and a word size who show a state of block floating obtained as sub information is explained. Drawing 11 is the example which showed a situation of a unit block when bit assignment becomes a triplet. A vertical axis shows a size of spectrum data which set a center to 0 or a MDCT coefficient and a horizontal axis shows frequency. In this example in a unit block eight spectrum data or a MDCT coefficient shown by abcdefgh exists and it has a size for Masakata or in a negative direction from 0 respectively. A scale factor which shows a state of block floating as mentioned above prepares a positive value in some sizes before and while taking a value more than spectrum data within a unit block or the maximum of an absolute value of a MDCT coefficient from the inside the minimum thing is adopted and it is considered as a scale factor of a unit block.

[0039] A scale-factor value is chosen in drawing 11 by the spectrum which shows the maximum of an absolute value. Quantization width within a unit block is determined by size of this scale factor and bit assignment. Although it is possible to express an octal when coding by a triplet originally (quantization) although an example of drawing 11 shows a case where bit assignment is a triplet here quantization width of a division-into-equal-parts rate is taken ternary every for Masakata and to a negative direction focusing on 0 a quantized value of seven values is taken in accordance with 0 and another numerals which can be expressed by a triplet suppose that it is intact. Here from a scale-factor value and a bit assigned value within a unit block a quantized value is determined and spectrum data or a MDCT coefficient within a unit block is quantized by the nearest quantized value. A portion of a black dot in drawing 11 shows a value by which each spectrum data or a MDCT coefficient within a unit block was quantized. That is drawing 11 shows an example of re quantization (it normalizes and quantizes).

[0040] If quantization width in a case of quantizing in a form which generally has the quantization width of a division-into-equal-parts rate for Masakata and in a negative direction focusing on 0 by a method as shown by drawing 11 is set to QV When a value of the unit Brock's scale factor is set to SF and it sets a bit assignment number to Nbit can ask for a certain unit Brock's quantization width QV by the following several 2 formulas.

[0041]

$$\text{[Equation 2]} QV = SF / \{2^{(Nb-1)} - 1\}$$

However $Nb \geq 2$ [0042] In this case the greatest quantization error that may happen within unit Brock is set to $QV/2$ of the half of quantization width.

[0043] Bit assignment about unit Brock of 0. Since all the spectra or MDCT data in unit Brock will be quantized by 0 the greatest quantization error that may happen within unit Brock in this case serves as the maximum of the spectrum in unit Brock or the absolute value of MDCT data.

[0044] When the size of unit Brock's quantization noise is considered here reconsideration of the number of the spectrum included in unit Brock and the size of a actual quantization error is needed strictly but. Since calculation is needed about all the spectra processing will become very large and is not so practical, however the greatest quantization error that may happen within unit Brock who asked by the above methods when there is no remarkable difference in the number of the spectrum in unit Brock -- for a slack reasonable possibility that quantization noise will become large highly a larger thing. Since it can consider that a bit necessity degree is large in simple and what is necessary is just to calculate by unit

Brocas compared with the case where it calculates about all the spectrait becomes possible about processing to decrease substantially.

[0045]In the fraction equalization circuit 313 by using an above-mentioned method first the greatest quantization error that may happen with each unit block about all the unit blocks is computed and let this value be a bit necessity degree of each unit block. Then for example there are few totals which totaled a computed quota bit than the usable number of bits and when a bit has arisen not much a bit necessity degree detects the greatest unit block and assigns a bit not much to the unit block. About a unit block which was newly able to assign a bit not much it is a bit assignment value after bit assignment not much and a bit necessity degree is recomputed by an above-mentioned method. Henceforth in the fraction equalization circuit 313 a bit necessity degree detects the greatest unit block and as long as calculation of assignment of a bit and a bit necessity degree can do again not much and a bit can assign processing of a series of ** not much it repeats. By a number of a spectrum within a unit block which a bit of the biggest value already allowed by a coding format is assigned at this time and cannot increase bit assignment and a unit block. What is necessary is just to except the unit block from an adjustment operation object when a bit is seldom sufficient quantity to increase bit assignment of a unit block. Bit remainder regulated treatment is performed in the fraction process circuit 313 and also it can also be performed in the coding correction circuit 314. However it is not necessary to perform bit insufficient regulated treatment in the coding correction circuit 314.

[0046]Here details about regulated treatment in bit remainder of **** are explained about a flow chart of drawing 4. By step ST-1 after setting the block number NO to zero it shifts to step ST-2 and it is judged whether it is bit assignment = 0. When judgment of step ST-2 is YES shift to step ST-3 set a bit necessity degree as the maximum of an absolute value of a signal component within a bit necessity degree = block and at the time of NO. It shifts to step ST-4 and a bit necessity degree is set as a bit necessity degree = peak child-ized error (QV/2). Step ST-After 3 and 4 shifts to step ST-5.

[0047]Step ST-In 5 judge whether it is the number of recording blocks = block number + 1 and if the number of recording blocks is NO after it shifts to step ST-6 and only 1 increases the block number NO it returns to step ST-2 and if it is YES it will shift to step ST-7 and it is judged whether an usable bit is an usable bit >= quota bit total.

[0048]By step ST-7 it shifts to step ST-9 at the time of NO and bit insufficient processing (processing after step ST-9 in drawing 5) is performed it shifts to step ST-8 at the time of YES and it sets a whole block as a block which can be adjusted. It is judged whether after step ST-8 shifts to step ST-10 and a block which can be adjusted exists. By judgment of step ST-10 it becomes the end at the time of NO it shifts to step ST-11 at the time of YES and a bit necessity degree detects the greatest block during [which can be adjusted] a block.

[0049]After step ST-11 shifts to step ST-12 and it is judged whether an increase in a single step of bit assignment of a detected block is possible. At the time of NO it shifts to step ST-14 in step ST-11 after carrying out the setting variation of the detected block to an adjustment improper block from a block which can be adjusted it returns to step ST-10 and it shifts to step ST-13 at the time of YES and the increase in a single step of the bit assignment of a detected block is carried out.

[0050]After step ST-13 computes a bit necessity degree of a detected block by shifting to step ST-15 <peak child-ized error QV/2>. After step ST-15 returns to step ST-11 after

computing a quota bit total by shifting to step ST-16.

[0051] Although the above explanation described an example when there are few totals which totaled a computed quota bit than the usable number of bits and a bit has arisen not much. When a total which totaled a computed quota bit is insufficient of more bits than the usable number of bits, a direction which deletes a bit from what has a small operation contrary to an above-mentioned example, i.e., bit necessity degree becomes realizable.

[0052] That is, there are more totals which totaled a computed quota bit for example than the usable number of bits, and when an insufficient bit has arisen, a bit necessity degree detects the minimum unit block and deletes a bit from the unit block. About a unit block which deleted a bit, it is a bit assignment value after bit deletion, and a bit necessity degree is recomputed by an above-mentioned method. Henceforth, in the fraction equalization circuit 313, a bit necessity degree detects the minimum unit block, a bit is deleted, and processing of a series of calculation of a bit necessity degree recarrying out is repeated until a total of a quota bit becomes below in the usable number of bits. What is necessary is just to make it bit assignment except from an adjustment operation object about a unit block of 0 at this time.

[0053] Here, details about adjustment operation when an above-mentioned bit is insufficient are explained with reference to drawing 5. By step ST-1, after setting the block number NO to zero, it shifts to step ST-2 and it is judged whether it is bit assignment = 0. When judgment of step ST-2 is YES, shift to step ST-3, set a bit necessity degree as the maximum of an absolute value of a signal component within a bit necessity degree = block and at the time of NO. It shifts to step ST-4 and a bit necessity degree is set as a bit necessity degree = peak child-ized error (QV/2). Step ST-After 3 and 4 shifts to step ST-5.

[0054] Step ST-In 5, judge whether it is the number of recording blocks = block number + 1, and if the number of recording blocks is NO, it shifts to step ST-6 and only 1 increases the block number NO, it returns to step ST-2, and if it is YES, it will shift to step ST-7, and it is judged whether an usable bit is an usable bit \geq quota bit total. Processing of step ST-1 - ST-7 is as common as bit remainder processing of drawing 4.

[0055] In step ST-7, at the time of YES, shift to step ST-8 and perform bit remainder processing (processing after step ST-8 in drawing 4) and it shifts to step ST-9 at the time of NO. During [which can be adjusted] a block (block whose bit assignment is not 0), a bit necessity degree shifts to step ST-10 after detecting the minimum ax block.

[0056] Step ST-In 10, after decreasing bit assignment of a detected block by one step, it shifts to step ST-11. Step ST-In 11, after computing a bit necessity degree of a detected block, it shifts to step ST-12. Step ST-In 12, after computing a total of the quota number of bits, it returns to step ST-7.

[0057] Since it is also possible to carry out in a form independent of an input signal, an above-mentioned fraction process. For example, bit remainder processing performs adjustment operation in a form which performs adjustment operation in a form where it asks for an above-mentioned bit necessity degree and for which it does not depend on an input signal about bit insufficient processing. Or, combination referred to as performing bit remainder processing in the form depending on an input signal and performing adjustment operation in a form where it asks for an above-mentioned bit necessity degree about bit insufficient processing is also possible conversely.

[0058] A bit assignment value after an output from the fraction process circuit 313, i.e., fraction adjustment of each unit block, is supplied to the coding correction circuit

314. In this coding correction circuit 314 with the unit block in which the minimum carried out thing adoption in a scale factor (normalization data) (information-compression parameter) prepared beforehand. In spite of carrying out bit assignment of 2 bits or more a spectrum within a unit block or when all MDCT coefficients (signal component within a two-dimensional block about time and frequency) detect what will be quantized by 0 and set bit assignment of a unit block to 0A bit which was being used for numerals of spectrum data or a MDCT coefficient is omitted and a bit obtained by abbreviation is distributed more effectively.

[0059] Below an example of correction in the coding correction circuit 314 is explained using drawing 12. Drawing 12 shows a situation of re quantization of unit block which has like drawing 11A lengthwise direction shall show a size of a spectrum or a MDCT coefficient (signal component in two-dimensional block about time and frequency) a transverse direction shall show frequency and eight spectra or a MDCT coefficient exists in unit block. In this example the maximum of a spectrum in unit block or an absolute value of a MDCT coefficient is smaller than the minimum thing in a scale factor (normalization data) (information-compression parameter) prepared beforehand. The minimum thing is adopted in a scale factor for which this unit block's scale-factor value was prepared beforehand and it is 2 bits and bit assignment shall have a quantized value of one every value and a total of three values in 0 and for Masakata and a negative direction as it was shown in drawing 12.

[0060] However when the maximum of a spectrum within a unit block or an absolute value of a MDCT coefficient is smaller than a value of a half of quantization width shown by a dotted line of drawing 12 like drawing 12 in the case of 2 bit assignment all the spectra or MDCT coefficients within a unit block are quantized by 0. That is although it is coded by "00" and all of eight spectra of a-h need 16 bits for record of a spectrum at least all quantized values are set to 0. In this case by sub information all records are set to 0 about a unit block. In this case since it becomes possible [a spectrum within a unit block or all MDCT coefficients] by not recording about that unit block namely changing bit assignment with 0 bit by sub information etc. to regard it as 0 It becomes possible to completely perform the same coding without using 16 bits which were being used for a spectrum or a MDCT quantization-of-coefficient value "00" in the case of above-mentioned 2 bit assignment. Namely by setting bit assignment of the unit block to 0 when all of a spectrum and a MDCT quantization-of-coefficient value are set to 0 although there is 2-bit or more assignment within a certain unit block it is possible to omit a spectrum or a bit which was being used for coding of a MDCT coefficient and to completely perform the same coding.

[0061] Also when it is not 2 bit assignment as shown in drawing 12 about a unit block with which the minimum thing in a scale factor (normalization data) (information-compression parameter) generally prepared beforehand was adopted as a scale-factor value. All spectra or MDCT quantization-of-coefficient values within a unit block which fulfills conditions of the several 3 following formula are set to 0 using the quantization width QV of a unit block searched for by several 2 above-mentioned formula by setting the maximum of an absolute value of a spectrum within the unit block or a MDCT coefficient to SPmax.

[0062] In the coding correction circuit 314 it is an above-mentioned method and a new usable bit can be obtained by detecting a unit block in which coding correction is possible using several 3 formula shown below and correcting bit assignment to 0.

[0063]

[Equation 3] $SP_{max} < QV/2$ [0064] Although based on the format of coding For example in addition to the method of setting bit assignment to 0 by the sub information which shows substantial bit assignment If not coding a block by the sub information which shows the validity of the unit block is shown when there is validity of a unit block i.e. the information which shows whether lends and there is in recording a unit block Since the abbreviation of the bit of the scale factor which is the sub information of the processing block and the sub information which was being used for bit assignment is also attained in such a case even if it attaches by the coding correction circuit 314 in drawing 3 sub information can be changed into the adapted form a bit can be omitted and a new usable bit can be obtained.

[0065] In the coding correction circuit 314 when correction by an above-mentioned method is possible reallocation which is the newly gained usable bit is performed but it is clear that adjustment operation by bit required ** degree calculation of a unit block performed in the above-mentioned fraction equalization circuit 313 can be used in the case of this reallocation. Data corrected by this coding correction circuit 314 is outputted as an output of the bit quota calculation circuit 118 in drawing 1 from an output terminal. [0066] Namely in the bit quota calculation circuit 118 in drawing 1, Data which processed an orthogonal transformation output spectrum sub information as main information by a system shown in drawing 3 mentioned above Word length which shows a scale factor (normalization data) (information-compression parameter) and a word size who show a state of block floating as sub information is obtained Based on this it codes in a form in drawing 1 which actually performed re quantization and followed a coding format in the adaptation bit allocation code-ized circuits 106 107 and 108.

[0067] With reference to drawing 13a decoder of a signal by which high efficiency coding was carried out with an encoder shown by drawing 1 mentioned above is explained. A MDCT coefficient by which each zone was quantized i.e. data equivalent to an output signal of the output terminals 112 114 and 116 in drawing 1 Block size information used having supplied the input terminal 1307 in drawing 13 (the length of a processing block) (information-compression parameter) i.e. data equivalent to an output signal of the output terminals 113 115 and 117 in drawing 1 is supplied to the input terminal 1308 in drawing 13. In the adaptation bit quota decoding circuit (adaptation bit quota decoding means) 1306 bit assignment is canceled using adaptation bit assignment information. Next a signal on a frequency axis is changed into a signal on a time-axis in the inverse-orthogonal-transformation (IMDCT) circuits (inverse-orthogonal-transformation means) 1303 1304 and 1305. A time-axis top signal of these partial zones is decrypted by all the zone signals and is outputted to the output terminal 1300 by the band composing filter (IQMF) circuits (band composition means) 1302 and 1301 in drawing 13.

[0068] Next with reference to drawing 14 - drawing 17 an embodiment of a digital signal recorder (a method) of this invention digital signal playback equipment (a method) a digital signal sending set (a method) and a digital signal receiving set (a method) is described. In drawing 14 and drawing 16 ENC shows an encoder of drawing 1 Tin shows the input terminal 100 DEC shows a decoder of drawing 13 and Tout shows the output terminal 1300.

[0069] In a recorder of drawing 14 supply an input digital signal from the input terminal Tin to the encoder ENC and it is encoded After carrying out predetermined abnormal

conditions after supplying the output terminals 112114 and 116 of an output of the encoder ENCi.e. an encoder of drawing 1 and an output signal from 113115 and 117 to modulation means MOD and multiplexing them or modulating each output signal respectively multiplexing or a second change tone is carried out. By recording devices (a magnetic head an optical head etc.) a modulating signal from modulation means MOD is recorded on the recording medium M.

[0070] In playback equipment of drawing 15 a record signal of the recording medium M of drawing 14 is reproduced by the reproduction means (a magnetic head an optical head etc.) and a recovery according to abnormal conditions according to the regenerative signal to modulation means MOD by the demodulation means DEM is performed. Supply a signal corresponding to a demodulation output from the demodulation means DEMi.e. an output from the output terminals 112114 and 116 of an encoder of drawing 1 to the input terminal 1307 of a decoder of drawing 13 and. A signal corresponding to an output from the output terminals 113115 and 117 of an encoder of drawing 1 is supplied to the input 1308 of drawing 13 is decoded and an output digital signal corresponding to an input digital signal is outputted to the output terminal Tout.

[0071] In a sending set of drawing 16 supply an input digital signal from the input terminal Tin to the encoder ENC and it is encoded. After carrying out predetermined abnormal conditions after supplying the output terminals 112114 and 116 of an output of the encoder ENCi.e. an encoder of drawing 1 and an output signal from 113115 and 117 to modulation means MOD and multiplexing them or modulating each output signal respectively multiplexing or a second change tone is carried out. A modulating signal from modulation means MOD is supplied to the transmitting means TX frequency conversion amplification etc. are performed a sending signal is made and the sending signal is transmitted by transmission antenna ANT-T which is a part of transmitting means TX.

[0072] In a receiving set of drawing 17 receiving antenna ANT-R which is a part of reception means RX receives a sending signal from transmission antenna ANT-T of drawing 16 and reception means RX performs the input signal for amplification reverse frequency conversion etc. A recovery according to abnormal conditions according to an input signal from reception means RX to modulation means MOD by the demodulation means DEM is performed. Supply a signal corresponding to a demodulation output from the demodulation means DEMi.e. an output from the output terminals 112114 and 116 of an encoder of drawing 1 to the input terminal 1307 of a decoder of drawing 13 and. A signal corresponding to an output from the output terminals 113115 and 117 of an encoder of drawing 1 is supplied to the input 1308 of drawing 13 is decoded and an output digital signal corresponding to an input digital signal is outputted to the output terminal Tout.

[0073] It is also possible for this invention not to be limited only to an above-mentioned embodiment and for bit reduction and an expanding device not to be further united with an above-mentioned recording and reproducing medium a bit reduction device or an expanding device for example without passing a recording medium and to connect the meantime with a circuit for data transfer etc. For example it is applicable not only to an audio PCM signal but signal processor such as a digital audio signal and a digital video signal.

[0074] The recording medium of this invention can aim at effective use of storage capacity by recording data compressed by an above-mentioned digital signal processing device. It can also be considered as a card which contains not only an optical disc

mentioned above but a magnetic disk IC memory and its memory as a recording medium of this invention and various recording media such as magnetic tape.

[0075]

[Effect of the Invention] According to above-mentioned **** this invention an input digital signal is divided into two or more frequency band components. Obtain the signal component within time and two or more two-dimensional blocks related with frequency and normalize based on the signal component within a two-dimensional block for every two-dimensional block about time and frequency and normalization data is obtained. The quantization coefficient which expresses the feature of the signal component within a two-dimensional block for every two-dimensional block about time and frequency is calculated. Determine bit allocation quantities based on the quantization coefficient for every two-dimensional block about time and frequency. Quantize the signal component within a block with normalization data and bit allocation quantities and carry out an information compression. A digital signal processing method which obtained the information-compression parameter for every [about time and frequency] two-dimensional block. A digital signal processing device, a digital signal record method, a digital signal recorder, a recording medium, a digital signal transmission method. By or the relation which performs integer-ization of bit allocation quantities etc. in a digital signal sending set when bit allocation quantities are computed for every two-dimensional block about time and frequency. When the total of the quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format in order to coincide this. The amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about above-mentioned time and frequency. Or based on the greatest signal component within a two-dimensional block, the greatest quantization error that may happen within a two-dimensional block is computed. Since it considers that the greatest quantization error is a bit necessity degree of two dimension blocks each and was made to perform adjustment operation of the bit based on the bit necessity degree. Adjustment operation depending on an input digital signal can be performed. more efficient coding can be realized by a throughput suitable as adjustment operation and what can aim at improvement in a static characteristic or a signal quality can be obtained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a block circuit diagram showing one example of a highly efficient compression encoding encoder usable to the bit rate compression encoding of an embodiment of the invention.

[Drawing 2] It is a figure showing the structure of the orthogonal transformation block in the case of bit compression.

[Drawing 3] It is a block circuit diagram showing the example of a bit distribution calculation function.

[Drawing 4] It is a flow chart which shows the regulated treatment of bit remainder.

[Drawing 5] It is a flow chart which shows regulated treatment with an insufficient bit.

[Drawing 6] It is a figure showing the spectrum of the zone divided in consideration of

each critical band and block floating.

[Drawing 7]It is a figure showing a masking spectrum.

[Drawing 8]It is the figure which compounded the minimum audible curve and the masking spectrum.

[Drawing 9]It is a figure showing the total amount remedial operation which pulls up the amount of bit assignment uniformly.

[Drawing 10]it is a figure showing the total amount remedial operation which boils the amount of bit assignment uniformly and reduces it.

[Drawing 11]It is a figure showing the example of quantization of the signal component in a bit assignment unit block.

[Drawing 12]In a bit assignment unit block all signal components are the figures showing the example quantized by 0.

[Drawing 13]It is a block circuit diagram showing one example of a highly efficient compression encoding decoder usable to the bit rate compression encoding of an above-mentioned embodiment.

[Drawing 14]It is a block diagram showing the recorder of an embodiment of the invention.

[Drawing 15]It is a block diagram showing the playback equipment of an embodiment of the invention.

[Drawing 16]It is a block diagram showing the sending set of an embodiment of the invention.

[Drawing 17]It is a block diagram showing the receiving set of an embodiment of the invention.

[Description of Notations]

101 and 102 A zone dividing filter and 103 104 and 105 Orthogonal transformation circuit (MDCT) 109 110 and 111 A block determining circuit 118 bit-assignment calculation circuit 106 107 and 108 An adaptation bit allocation code-ized circuit and the 302 whole zones Energy calculation machine A 303 reeving filter and 304 An adding machine 305 function generators 306 dividers 307 A composing device and 308 A subtractor 309 delay circuits and 310 Permissible noise amendment machine 312 The minimum audible curve generator 313 fraction equalization circuit and 314 A coding correction circuit 130 11302 band composing filters (IQMF) and 1303 1304 and 1305 An inverse-orthogonal-transformation circuit (IMDCT) and 1306 Adaptation bit quota decoding circuit.
